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(72) Inventor PATRICK JOSEPH MALLON

(54) INJECTION MOULDING MACHINERY

(71) We, IMPERIAL CHEMICAL INDUSTRIES LIMITED, Imperial Chemical House, Millbank, London SW1P 3JF, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to injection moulding and in particular to the production of injection moulded articles having a skin of synthetic resin material enclosing a core of dissimilar synthetic resin material at all points away from the sprue area of the moulding, i.e. the area corresponding to the position or positions wherein the materials are injected into the mould cavity.

Such articles may be made by sequentially injecting the skin and core materials into a mould cavity so that the core material is injected to within the skin material and extends the latter to fill the mould cavity. An example of this process, wherein the core material is foamable, is described in our British Patent Specification 1,156,217.

During the injection cycle it is necessary to inject different materials, i.e. the skin material and then the core material, and so it is necessary to switch from injection of one material to another.

In some cases it may be possible to arrange that injection is continuous, for example by arranging plugs of the materials to be injected in series in an injection barrel of an injection moulding machine. However this technique is less versatile than systems using separate injection barrels as the same injection conditions, e.g. temperatures, have to be used for each material and also contamination of the skin material by core material is possible.

Accordingly it is generally necessary to provide some arrangement to switch between the two injection barrels. A simple method of switching involves the use of a multiway tap such as is described in our British Patent Specification 1,219,097. Another method wherein switching is performed without the use of such a tap is described in our British Patent Specification 1,332,883. However unless the supplies of material from the injection barrels are arranged to be coaxial with one another, which gives rise to practical engineering difficulties, it will be seen that one material will be introduced into the sprue channel from one direction while the other material is introduced from another direction. This means that when injection of the core material commences, it will first be introduced down one side of the sprue channel.

We have found that this tends to give an uneven, or lopsided, distribution of the core material inside the skin material, even though the core material may only be introduced down one side of the sprue channel for a very small fraction of a second before it is introduced over all the sprue channel.

We have found this particularly to be true where it is desired to commence injection of the core material before injection of the skin material is stopped; i.e. where there is a period, often only a small fraction of a second, during which both materials are injected. Such "overlapping" injection is often desirable to prevent the melt front in the mould cavity from becoming stationary since we have noticed that if the melt front temporarily stops moving and is not in contact with the mould wall, a line may appear on the surface of the moulded article at a point corresponding to the position of the melt front where it was temporarily halted. This line is believed to be caused by preferential solidification of the melt at the point where the melt front is stationary. Some materials exhibit this line, herein termed a hesitation mark, to a greater extent than other materials.

We have now devised a process wherein the core material is first injected down the centre of the sprue channel.

Accordingly we provide a device suitable for use in an injection unit of a double barrelled injection moulding machine comprising (i) a housing having a circular cross-sectioned sprue channel for connection to the mould cavity, (ii) a member, having a passage of circular cross-section therein for

communication with the inlet of said sprue channel, slidably movable with respect to the housing, the outlet of the passage being the same size as the inlet of the sprue channel, said member being movable from a first position wherein the axis of said passage lies on the axis of said sprue channel to a second position wherein an imaginary line on the surface of said passage lying in the same plane as the axis of the passage lies on the axis of said sprue channel, (iii) means for supplying materials from the barrels of the injection moulding machine to said passage arranged such that when injection of the second material to be injected commences with the member in said second position, the second material first enters said passage along said imaginary line, and (iv) means to move said member relative to said housing between said first and second positions.

We also provide a process for the production of laminar articles having a core of an injection mouldable synthetic resin composition substantially totally enclosed in a skin of a dissimilar injection mouldable synthetic resin composition wherein the skin composition is injected into a mould cavity from a first source via a sprue channel having an inlet of circular cross-section and, before the interior of the skin composition injected into the mould cavity has solidified, the core composition is injected from a source separate from the source of the skin composition through said sprue channel such that it tends to be first injected offset from the axis of the sprue channel towards one side thereof, and maintaining the compositions in the mould cavity until they have solidified, characterised by providing a member slidably mounted in a housing, said member having a passage of circular cross-section for communication with the inlet of the sprue channel, the outlet of said passage being the same size as the inlet of the sprue channel and injecting the skin composition through said passage while the member is in a position wherein the axis of the passage lies on the axis of the sprue channel and, before injection of the core material, sliding said member in a direction opposite to that side of the sprue channel to which the core material tends to be first injected until a line on the surface of the passage lies on the axis of said sprue channel and then commencing injection of the core material whereby the core material is first injected along said line, and returning the member to the position wherein the axis of the passage lies on the axis of the sprue channel as the injection of core material builds up.

In operation the member is moved to the second position just before injection of the second (core) material commences so that as the second material first enters the passage it does so down the aforesaid line which is at the centre of the sprue channel. Thus the core material initially is injected down the centre of the sprue channel and hence down the centre of the skin material already in the sprue channel. The member is then moved back to the first position as the injection of the core material builds up.

In its simplest form, which is applicable to the injection system described in our British Patent Specification 1,332,883, the member is a sliding bar having a cylindrical passageway mounted in a housing having a cylindrical sprue channel.

In a preferred form the device is arranged in conjunction with a multiway tap, preferably of the rotary type. In the latter case the member is preferably a cylindrical sleeve rotatably mounted in the housing with the rotary tap mounted inside the sleeve. The rotary tap is preferably one having an overlapping injection position.

If desired, where no multiway selection tap is used, for example as in the system of British Patent Specification 1,332,883, or the multiway tap has no shut-off position, the slidably movable member can be used to provide a shut-off position, to permit the mould to be opened and the moulding removed, by providing a third position for the slidably movable member wherein the passage is not in communication with the sprue channel.

It will be appreciated that, when the member is in the position wherein the axis of the passage lies along the axis of the sprue channel, the outlet of the passage is coincident with the inlet of the sprue channel.

The invention is illustrated by reference to the drawings accompanying the provisional Specification wherein Figure 1 is a longitudinal cross-section of a housing enclosing a sprue channel showing the tendency of the core material to be injected offset from the axis of the sprue channel.

Figure 2 is a view similar to Figure 1 and shows the position when injection of core material is commenced using a member in accordance with the invention to divert the core material to the axis of the sprue channel.

Figure 3 is a section along the line A—A of Figure 2.

Figure 4 is a view similar to Figure 2 but showing the position as the injection of core material builds up.

Figure 5 is a section along the line B—B of Figure 4.

Figure 6 is a view similar to Figure 2 but showing the position on commencement of a further injection of skin material.

Figure 7 is a view similar to Figures 1, 2 and 4 but showing the member in a "shut-off" position to prevent further injection.

Figures 8 to 15 are cross-sectional views of a multiway tap embodying a sliding member in accordance with the present invention showing the sequence of positions of the tap and member during the injection cycle.

Figure 16 is a view similar to Figure 8 but showing the use of the sliding member instead of the tap body to achieve a "shut-off" position.

Figure 17 is a longitudinal section through a tap housing showing a tap design alternative to that of Figures 8 to 16.

Figure 18 is a section along the line C—C of Figure 17 and shows the tap in a position corresponding to that of Figure 14.

In Figure 1 is shown a housing 1 in which a sprue channel 2 is provided, communicating with a mould cavity (not shown). Skin and core materials are injected sequentially from separate sources (not shown). Skin material passes into the sprue channel 2 via a channel 3 while core material passes via a channel 4.

If injection of core material is commenced before injection of skin material is completed the first part of the core material will be deflected, by the injecting skin material, towards that side of the sprue channel into which the channel 4 leads. Thus the core material is initially injected off centre in relation to the sprue channel. In the present invention this is overcome, as shown in Figure 2, by sliding, before commencement of core material injection, a member 5 in a direction away from the side of the sprue channel to which the core material tends to be deflected. This member has a cylindrical passage 6 therein which is the same size as the adjacent part 7 of the sprue channel 2. The member is moved by such a distance that a line on the surface of the passage lies on the axis of the sprue channel 2. In this particular embodiment this is achieved by moving the member a distance equal to the radius of the passage.

By virtue of the position of member 5 skin material is trapped in a dead space 8 adjacent the member 5 and this causes the core material 9 to take a central path.

The core material is thus first injected along the lower edge 10 of the passage 6, i.e. along the line on the surface of the passage lying on the axis of the sprue channel 2. (See also Figure 3).

As the injection of core material proceeds, and injection of skin material comes to a halt, the member 5 is retracted, as shown in Figure 4, thereby permitting the flow of core material to build up evenly to fill the sprue channel (see also Figure 5).

If desired, after injection of the core material, a further quantity of skin material may be injected. This has the advantage that when the sprue, i.e. the material moulded in the sprue channel, is removed from the final article, only a narrow annulus of core material will be exposed, whereas if no further quantity of skin material is injected, the area exposed on removal of the sprue will consist of core material which may detract from the appearance of the article.

If such a further quantity of skin material is injected, it may be desirable to ensure it is injected centrally down the sprue channel and so the member may be slid in the opposite direction before commencement of injection of the further quantity of skin material (see Figure 6) and then retracted as before as the injection of skin material builds up. On completion of injection of the further quantity of skin material, or of core material if there is no further injection of skin material, the sliding member may be moved to isolate the sprue channel from the channels 3, 4 (see Figure 7) thereby permitting the article in the mould to be solidified and removed together with the material moulded in the sprue channel 2 and the sources of the skin and core materials, for example, injection barrels of the reciprocating screw type, to be recharged. In this case, the injection of a second amount of skin material has the additional advantage of sweeping the passage 6 clear of core material so that, on injection of the skin material in the next moulding cycle the first injected skin material is not contaminated by core material. Indeed, the further injection of skin material will normally cause the lower end 11 of the core injection channel 4 to be filled with skin material by virtue of melt compression of the core material in channel 4.

In the arrangement shown in Figures 8 to 16, the sliding member 5 is provided as a cylindrical sleeve to a rotary multiway tap body 12. The housing 1 in which the sleeve 5 is rotatably mounted has channels 3, 4 connected to the sources (not shown) of skin and core material.

The sleeve 5 has three passages therethrough, one passage 6 for communication with the sprue channel 2, and passages 13, 14 for communication with the channels 3 and 4. The passages 6, 13, 14 are arranged such that when passage 6 is fully in communication with sprue channel 2, passages 13, 14 are fully in communication with the channels 3, 4 respectively.

The openings, or inlets, of passages 13, 14 are made the same size as the outlets of channels 3, 4 to avoid the creation of unswept dead spaces.

The outlet of passage 6 is circular and is the same size as the inlet of sprue channel 2.

Passage 6 is tapered so that it is of the form of a truncated cone having its apex at the axis of the tap body 12. The reason for this will be explained hereinafter.

The outlets of the passages 13, 14 are larger than the inlet to passage 6, i.e. passage 6 subtends a smaller angle at the axis of the tap body than do the outlets of passages 13, 14.

Passages 13, 14 can be connected in turn to the inlet of passage 6 by means of bores 15, 16 in the tap body 12. These bores are tapered so that their inlets are the same size as the outlets of passages 13, 14 while their outlets

are the same size as the inlet of passage 6. [The outlets to the bores 15, 16 may, if desired, be flared so that the outlets are effectively closer together.] The distance between the nearest points of the outlets of bores 15, 16 is less than the diameter of the inlet of passage 6 so that, for a period during switching from injection of skin material to injection of core material, or vice versa, both bores 15 and 16 are in communication with the inlet of passage 6.

In Figure 8, the tap body 12 is shown in a position wherein neither bore 15, nor bore 16 is in communication with passage 6 and so the sprue channel 2 is isolated from channels 3, 4 and so no injection can take place. This is thus the position at the start of the injection cycle.

To commence injection, tap body 12 is rotated clockwise. The inlet of bore 15 communicates with the outlet of passage 13 before the outlet of bore 15 communicates with passage 6, since the inlet to bore 15 is larger than its outlet, and so the material remaining in bore 15 from the previous moulding cycle is pressurized to the pressure appertaining in channel 3. Then the outlet of bore 15 communicates with passage 6 to commence injection of skin material. The system is then as depicted in Figure 9.

When the injection of skin material is nearly completed, sleeve 5, together with tap body 12, is rotated clockwise until the lower edge of passage 6 lies on the axis of sprue channel 2. It will be appreciated that if passage 6 had not been tapered this edge would not lie on the axis. The significance of this is that it is desired to inject the core material down the centre of the sprue channel. If the lower edge of the passage 6 was inclined to the axis, as would be the case if it had not been tapered, then on commencement of injection of core material it would be directed off centre.

Injection of skin material continues since channel 3 is still connected to bore 15 by passage 13. Channel 4 is also still connected to passage 14. This is the position shown in Figure 10.

Tap body 12 is then rotated further clockwise while sleeve 5 is maintained in its Figure 9 position.

Bore 16 is thus brought into communication with passage 14 and hence channel 4 and so material remaining in bore 16 is brought to the pressure on the core material in channel 4. Injection of core material commences when the outlet of bore 16 communicates with passage 6. In Figure 11, the system is shown wherein injection of core material is about to commence. It is seen that the core material will initially be injected along the axis of the sprue channel. The tap body is then further rotated clockwise. It is seen that this will progressively cut down the area through which skin material can be injected. As the tap body is thus rotated clockwise, the sleeve 5 is rotated anticlockwise towards its original position thereby permitting the core material to fill a larger proportion of the sprue channel cross-section (see Figure 12). Rotation of the sleeve 5 anticlockwise and tap body 12 clockwise is continued until at the moment the outlet of bore 15 ceases to be in communication with passage 6 thus preventing further injection of skin material, sleeve 5 is back in its original position. The system is then as shown in Figure 13.

Tap body 12 is then rotated further clockwise to bring the outlet of bore 16 fully into communication with passage 6 and the inlet of bore 16 fully into communication with passage 14. At the same time this rotation of tap body 12 moves the inlet of bore 15 out of communication with passage 13. The system is then as shown in Figure 14.

If desired a further charge of skin material can be injected after the core material by reversing the process, i.e. moving tap body 12 anticlockwise. If it is desired that the further charge of skin material is injected down the centre of the sprue channel, then sleeve 5 will have to be rotated anticlockwise and then clockwise.

The time taken to switch from injection of skin material to core material, i.e. from the position of Figure 9 to that of Figure 14, or vice versa, may be very short; for example it may be a fractional part of a second.

After injection of the core material, or a further quantity of skin material, the tap is turned to the "shut-off" position of Figure 8. If a further quantity of skin material is injected this involves, as a final step, the rotation of the tap body anticlockwise from the position of Figure 9 (wherein the further quantity of skin material would be injecting) to that of Figure 8. However if no further quantity of skin material is injected then to change from the position of Figure 14 to that of Figure 8 it is necessary (unless, as is described hereinafter, it is possible to rotate the tap through 360° without bore 16 connecting with passage 13 and bore 15 connecting with passage 14 and neither bore connecting with passage 6) to rotate sleeve 5 anticlockwise to isolate the sprue channel 2 from the bore 16 to the position of Figure 15. Tap body 12 is then rotated anticlockwise until the outlet of bore 15 has passed passage 6 and then the sleeve 5 and tap body 12 are together rotated clockwise to the position of Figure 8.

Instead of turning the tap body to the position of Figure 8 to provide a shut-off position when a further injection of skin material is employed, it is possible to obtain shut-off by rotating the sleeve 5 clockwise from the position of Fig. 9 (which will be the position during the further injection of skin material). This "shut-off" position is shown in Figure 16.

The next injection cycle is commenced by

returning sleeve 5 to the position of Figure 9.

In the arrangement depicted in Figures 17 and 18, the bores 15 and 16 are skewed so that the axes of channels 3 and 4, and sprue channel 2 all lie in the same plane as the axis of rotation of the tap body 12 while the centres of the outlets of bores 15, 16 and of the inlet of passage 6 lie in a plane perpendicular to the axis of rotation of the tap body 12. Thus the channels 3 and 4 are spaced apart laterally. This arrangement enables the tap body 12 to be rotated to the shut-off position corresponding to Figure 8 without the necessity of injecting a further quantity of skin material and without the necessity of rotating sleeve 5. This arrangement is furthermore preferred from a practical engineering viewpoint.

WHAT WE CLAIM IS:—

1. A device suitable for use in an injection unit of a double barrelled injection moulding machine comprising (i) a housing having a circular cross-sectioned sprue channel for connection to the mould cavity, (ii) a member, having a passage of circular cross-section therein for communication with the inlet of said sprue channel, slidably movable with respect to the housing, the outlet of the passage being the same size as the inlet of the sprue channel, said member being movable from a first position wherein the axis of said passage lies on the axis of said sprue channel to a second position wherein an imaginary line on the surface of said passage lying in the same plane as the axis of the passage lies on the axis of said sprue channel, (iii) means for supplying materials from the barrels of the injection moulding machine to said passage arranged such that when injection of the second material to be injected commences with the member in said second position, the second material first enters said passage along said imaginary line, and (iv) means to move said member relative to said housing between said first and second positions.

2. A device as claimed in claim 1 wherein the member is also movable to a third position wherein the passage is isolated from the inlet of the sprue channel.

3. A device as claimed in claim 1 or claim 2 wherein the member comprises a cylindrical sleeve and a rotary tap body is slidably mounted inside the sleeve, said tap body being movable from a first position wherein material from one barrel of the injection moulding machine can be supplied to the passage in the sleeve, to a second position wherein material from the other barrel of the injection moulding machine can be supplied to the passage in the sleeve.

4. A device as claimed in claim 3 wherein the tap body has two bores therein, each for connection with a barrel of the injection moulding machine, via separate passages in the sleeve.

5. A device as claimed in claim 4 wherein the distance between the nearest points of the outlets of the bores in the tap body is less than the diameter of the inlet of the passage in the sleeve that communicates with the sprue channel , so that, as the tap body switches between its first and second positions, for a period, both bores are in communication with the inlet of the passage in the sleeve that communicates with the sprue channel.

6. A device as claimed in claim 4 or claim 5 wherein the inlet of the passage in the sleeve that communicates with the sprue channel subtends a smaller angle at the axis of the tap body than those subtended by the outlets of the passages in the sleeve that serve to connect the injection barrels with the bores of the tap body, and the inlets of the bores are the same size as the outlets of the passages in the sleeve that connect with the injection barrels and the outlets of the bores are the same size as the inlet of the passage in the sleeve that communicates with the sprue channel.

7. A device as claimed in any of claims 4 to 6 wherein the bores are skewed in the tap body so that the centres of the outlets of the bores and of the inlet of the passage in the sleeve that communicates with the sprue channel lie in a plane perpendicular to the axis of rotation of the tap body while the axes of the supply channels from the injection barrels to the passages in the sleeve that serve to connect the injection barrels to the bores in the tap body, and the axis of the sprue channel lie in the same plane as the axis of rotation of the tap body.

8. A device as claimed in any of claims 3 to 7 wherein the tap body is movable to a third position wherein neither barrel of the injection moulding machine is connected to the passage in the sleeve that communicates with the sprue channel.

9. A device as claimed in claim 1 substantially as hereinbefore described with particular reference to Figures 2 to 18 of the drawings accormpanying the provisional specification.

10. A process for the production of laminar articles having a core of an injection mouldable synthetic resin composition substantially totally enclosed in a skin of a dissimilar injection mouldable synthetic resin composition wherein the skin composition is injected into a mould cavity from a first source via a sprue channel having an inlet of circular cross-section and, before the interior of the skin composition injected into the mould cavity has solidified, the core composition is injected from a source separate from the source of the skin composition through said sprue channel such that it tends to be first injected offset thereof, and main-

taining the compositions in the mould cavity until they have solidified, characterised by providing a member slidably mounted in a housing, said member having a passage of circular cross-section for communication with the inlet of the sprue channel, the outlet of said passage being the same size as the inlet of the sprue channel and injecting the skin composition through said passage while the member is in a position wherein the axis of the passage lies on the axis of the sprue channel and, before injection of the core material, sliding said member in a direction opposite to that side of the sprue channel to which the core material tends to be first injected until a line on the surface of the passage lies on the axis of said sprue channel and then commencing injection of the core material whereby the core material is first injected along said line, and returning the member to the position wherein the axis of the passage lies on the axis of the sprue channel as the injection of core material builds up.

11. A process as claimed in claim 10 wherein said member is moved to a position wherein the passage is isolated from the sprue channel after completion of injection of the skin and core materials.

12. A process as claimed in claim 10 or claim 11 wherein injection of core material is commenced before completion of injection of skin material.

13. A process as claimed in any of claims 10 to 12 wherein, after injection of the core material, a further quantity of skin material is injected.

14. A process as claimed in any of claims 10 to 13 wherein the skin and core materials are supplied to the passage from a multiway tap which is movable between a first position wherein skin material is supplied and a second position wherein core material is supplied.

15. A process as claimed in claim 14 wherein after completion of injection of the skin and core materials, the tap is moved to a third position wherein neither material is supplied to the passage.

16. A process as claimed in claim 10 substantially as hereinbefore described with particular reference to that described in relation to Figures 2 to 18 of the drawings accompanying the provisional specification.

17. Injection moulded articles whenever made by a process as claimed in any of claims 10 to 16.

C. GRATWICK,
Agent for the Applicants.

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1384434 PROVISIONAL SPECIFICATION

6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

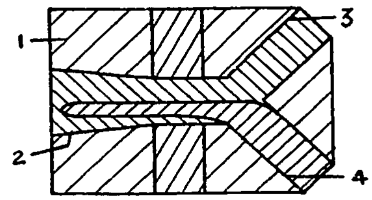

FIG. 1

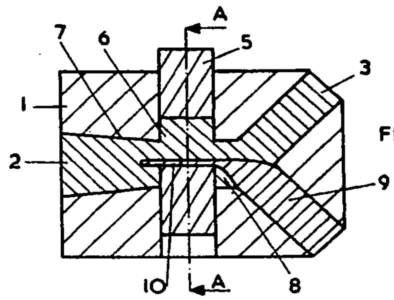

FIG. 2

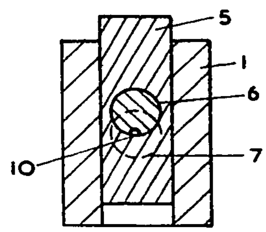

FIG. 3

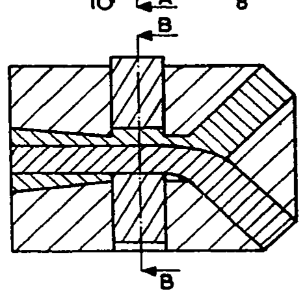

FIG. 4

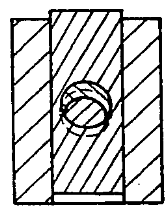
FIG. 5

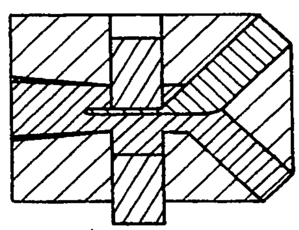
FIG. 6

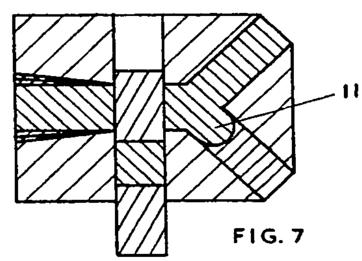

FIG. 7

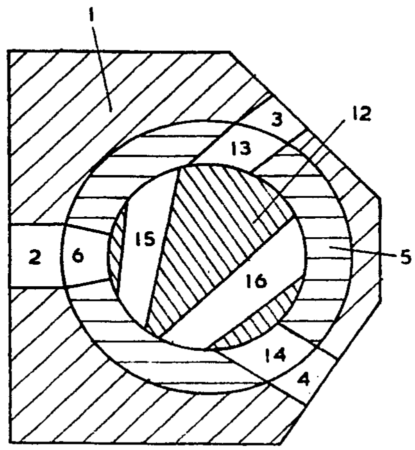

FIG.8

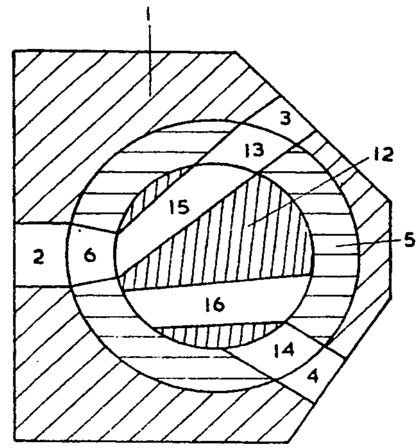

FIG. 9

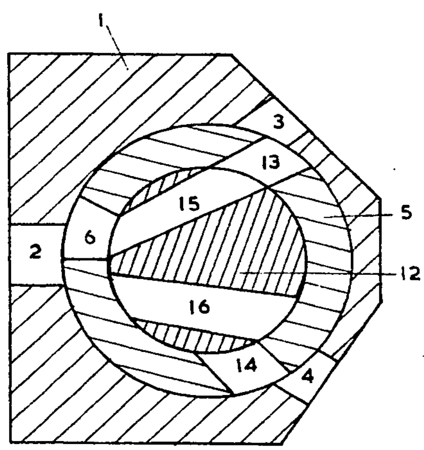

FIG. 10

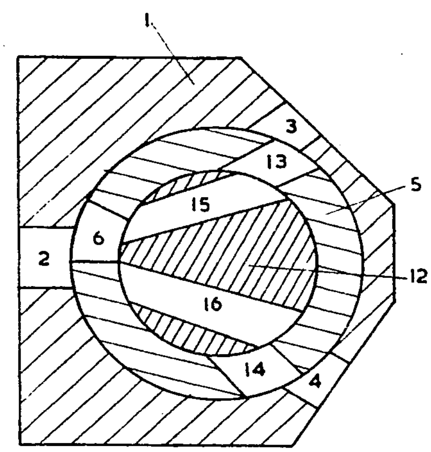

FIG. 11

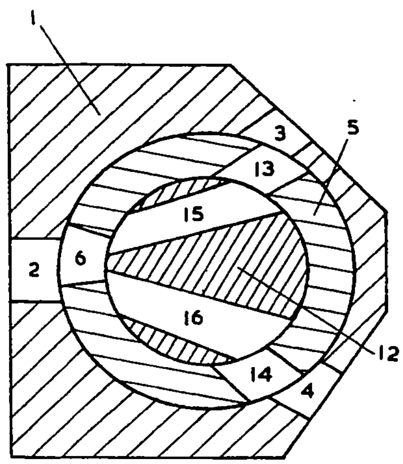

FIG. 12

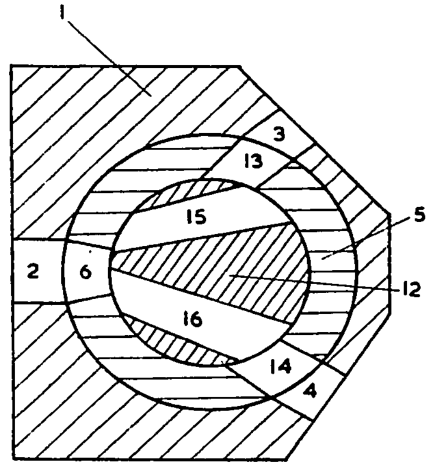

FIG. 13

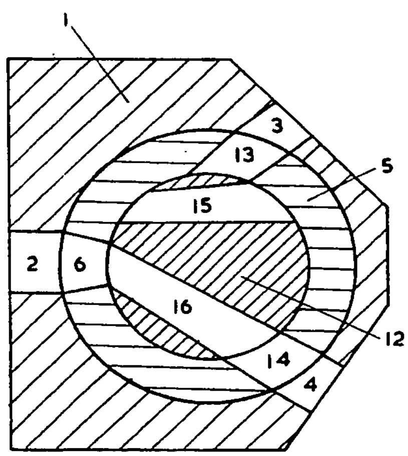

FIG. 14

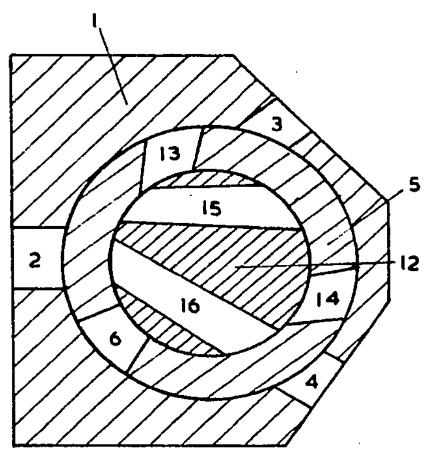

FIG. 15

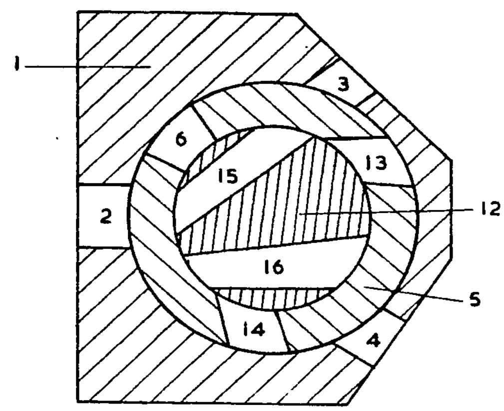

FIG. 16

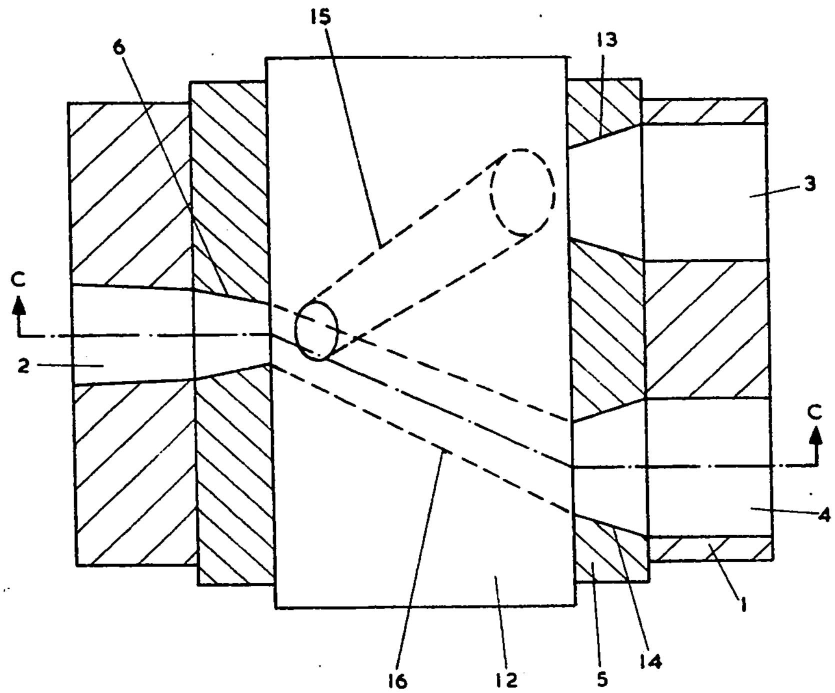

FIG. 17

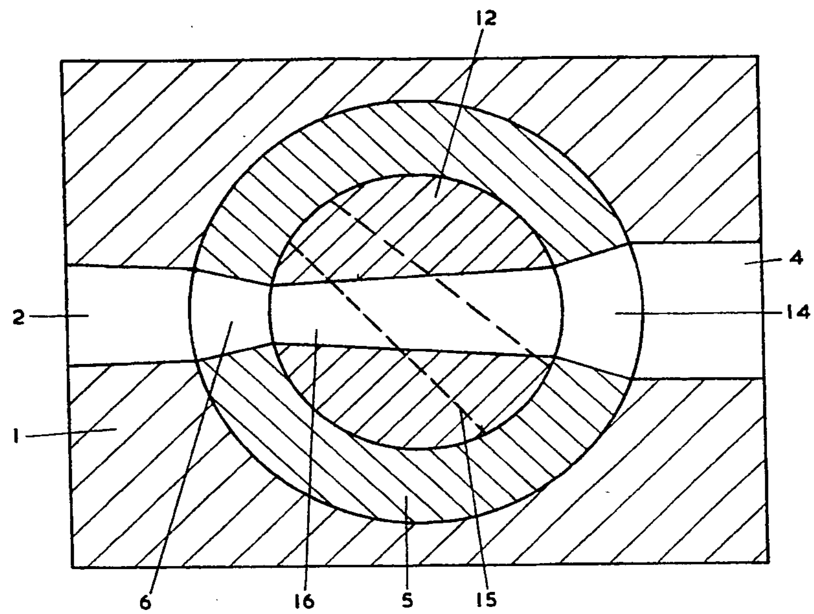

FIG. 18